PSYCHE

A JOURNAL OF ENTOMOLOGY

ESTABLISHED IN 1874

VOL. XLIV DECEMBER, 1937 No. 4

CAMBRIDGE ENTOMOLOGICAL CLUB
1874

TABLE OF CONTENTS.

Notes on the Habits of Strumigenys. *William Steel Creighton*... 97

Cannibalism Among Lepidopterous Larvæ. *V. G. Dethier*....... 110

A Megamorphic and Two Curious Mimetic Flies. *Frank M. Hull* 116

West Indian Carabidæ IV: Three New Colpodes. *P. J. Darlington, Jr*.................................... 122

Observations and Experiments on the Case-building Instinct of Two Species of Trichoptera. *Manton Copeland and Sears Crowell* 125

Synonymy of the Genus Pseudoxenos Saunders (Strepsiptera, Xenidæ) and Records of Stylopized Hymenoptera from North Carolina. *Richard M. Bohart*.......................... 132

Biology of the Tachinid *Winthemia datanæ* Tns. *Frank L. Marsh* 138

Notes on the Courtship and Mating of the Fly, *Ptecticus trivittatus* Say. *Phil Rau*.................................... 141

Index to Volume 44.. 143

CAMBRIDGE ENTOMOLOGICAL CLUB

OFFICERS FOR 1937-1938

President	C. A. Frost
Vice-President	J. C. Bequaert
Secretary	V. G. Dethier
Treasurer	Richard Dow
Executive Committee	Thomas Barbour F. M. Carpenter C. H. Blake

EDITORIAL BOARD OF PSYCHE

EDITOR-IN-CHIEF

C. T. Brues, Harvard University

ASSOCIATE EDITOR

F. M. Carpenter, Harvard University

CONSULTING EDITORS

Nathan Banks,
Harvard University.

Thomas Barbour,
Harvard University.

Richard Dow,
New England Museum of
Natural History,
Boston, Mass.

A. E. Emerson,
University of Chicago.

A. L. Melander,
College of the
City of New York.

J. G. Needham,
Cornell University.

PSYCHE is published quarterly, the issues appearing in March, June, September, and December. Subscription price, per year, payable in advance: $2.00 to Subscribers in the United States; foreign postage, 25 cents extra, Canada 15 cents. Single copies, 65 cents.

Cheques and remittances should be addressed to Treasurer, Cambridge Entomological Club, Biological Laboratories, Harvard University, Cambridge, Mass.

Orders for back volumes, missing numbers, notices of change of address, etc., should be sent to Professor F. M. Carpenter, Biological Laboratories, Harvard University, Cambridge, Mass.

IMPORTANT NOTICE TO CONTRIBUTORS

Manuscripts intended for publication, books intended for review, and other editorial matter, should be addressed to Professor C. T. Brues, Biological Laboratories, Harvard University, Cambridge, Mass.

Authors contributing articles over 8 printed pages in length will be required to bear a part of the extra expense, for additional pages. This expense will be that of typesetting only, which is about $2.00 per page. The actual cost of preparing cuts for all illustrations must be borne by contributors; the expense for full page plates from line drawings is approximately $5.00 each, and for full page half-tones, $7.50 each; smaller sizes in proportion.

AUTHOR'S SEPARATES

Reprints of articles may be secured by authors, if they are ordered before, or at the time proofs are received for corrections. The cost of these will be furnished by the Editor on application.

Printed by the Eliot Press Inc., Jamaica Plain, Mass., U. S. A.

PSYCHE

VOL. XLIV DECEMBER, 1937 No. 4

NOTES ON THE HABITS OF STRUMIGENYS

By William Steel Creighton

Dept. of Biology, College of the City of New York

The singular cephalic characteristics which mark the ants of the genus Strumigenys have given rise to a number of postulates concerning the habits of these strange insects. Such postulates have, for the most part, remained speculative. This result is not surprising if one considers the obscurity which surrounds these forms. Although widely distributed and not excessively rare in some areas Strumigenys is one of the least conspicuous genera in our ant fauna. This will not, however, entirely account for the dearth of ecological data concerning the group. Published records attest that nearly every American myrmecologist has taken specimens of Strumigenys in the field. The opportunity for habit studies has been allowed to pass and the specimens have given rise to little more than an additional locality record. If it were not for the abundant evidence to the contrary one might almost believe that myrmecologists suffer from a distressing sort of alcoholism which impells them to pop rare specimens into that fluid as soon as these are unearthed. This might have been the fate of the colony described in this paper had it not been accidentally divided into two groups on exposure. The first of these went into alcohol at once but the second was not noticed until the initial acquisitive frenzy had passed. It was thereupon placed in a live-bottle where it survived a three day trip home. The ensuing notes are based upon observations made on this fragment of the original colony.

I regard the specimens as identical with that form of *S. louisianae* described by Dr. M. R. Smith as the subspecies *laticephala.* It may be recalled that Dr. Smith in his monograph of the North American Strumigenys (1) expressed the belief that the range of the subspecies *laticephala* might be more extensive than his published records indicated. The locality of the colony described herein fully supports Dr. Smith's supposition and at the same time furnishes a new northeastern record not only for the subspecies but for the subgenus as well. The insects were secured on April 22 in a well-developed stand of pine a mile or two to the east of Rocky Mount, North Carolina. The previous records of this subspecies were limited to Mississippi and Alabama where its known range extended almost to the northern border of each state. In point of fact the North Carolina record is only about eighty miles further to the north but the wide swing to the east is very significant. It definitely places *laticephala* with that interesting group of southern species whose range begins in the Gulf States and extends northward through the tidewater area of the Atlantic seaboard. It is, perhaps, not too much to assume that the northern end of the range of *laticephala* may lie in the New Jersey pine barrens.

On reaching home the fifteen surviving workers were placed in a small plaster nest. In addition I placed in the nest chambers a quantity of the bark which had formed the walls of the original nest. Except for shredding this bark so that it would not interfere with the closing of the glass top of the nest it was in its original condition. This was done with a view to promoting fungal growth since Kennedy and Schramm, in a paper published in 1933 (2) had postulated that these insects might be fungus feeders. Their supposition was based upon an analysis of *S.* (*Cephaloxys*) *ohioensis*, a species which they described in the same paper. After boiling the insects in KOH the cleared specimens were examined for chitinous remains of other insects. The results were negative, no such fragments being found. Accordingly Kennedy and Schramm gave up the idea that Strumigenys is insectivorous because they believe that such fragments occur "in the bodies of other ants which feed on insects". I find this statement confusing. I presume that it must refer to the infra-buccal pocket which sometimes contains chitinous remains. I cannot believe that the authors imply that such fragments pass into the abdominal portion of the digestive tract. If the infrabuccal pocket is meant, however, it should be recalled that Wheeler and Bailey have clearly shown (3) that this structure may be entirely devoid of recognizable insect remains in the case of an ant known to be insectivorous. The absence of such remains is, therefore, no proof that insect tissues are not used as food. While I could not accept the above conclusion as offered I was anxious to test the hypothesis of the two authors that the ants might be fungus feeders. This seemed entirely amenable to investigation if living specimens were available for study. I determined, therefore, to give the colony every opportunity for cultivating a food fungus. With this in mind the nest was kept very moist and there soon developed on the surface of the bark two distinctly different fungi.

The first of these appeared during the initial twenty-four hours after the establishment of the artificial nest. It consisted of numerous, slender, twisted hyphae. These colorless strands strongly resembled the filaments of Rhizopus but they never formed a heavy mycelium nor, as far as I could tell, did they ever produce fruiting bodies. The second fungus appeared on the following day. It consisted of spherical tufts of short hyphae radially arranged around what seemed to be a central point of attachment. The diameter of the mature colony was about one millimeter and as they approached maturity the color changed from white to blue-grey. As each tuft seemed entirely isolated and as they showed a progressive development through the nest chambers it seems likely that this second fungus may have formed spores although I never saw any.

During the course of many hours of observation I saw the Strumigenys repeatedly crawl around and over each of the two fungi. When doing so they would touch the hyphæ with their antennæ but, as they constantly explore their surroundings with these organs while moving, there is no reason to attribute special significance to this fact. In no case did I see any evidence of the ants feeding on the fungus and it was only rarely that the palps came in contact with them. It may be argued that neither of the two fungi which developed on the bark was the hypothetical food fungus. I see no reason to suppose that such a view can be maintained. From what we know of the Attine ants there is abundant evidence to show that the fungus feeders permit only the food fungus to develop in the nest. Moreover, while the full development of the mycelia of such a fungus is usually restricted to the actual garden, fragments of the hyphæ are widely dispersed throughout the nest because they adhere to the bodies of insects which tend them. From what has been said above it is obvious that the conditions in the artificial nest were favorable to the growth of fungi. If the ants had been cultivating a food fungus it is scarcely thinkable that it should have failed to develop while two foreign fungi grew well.

It may further be objected that Kennedy and Schramm applied their postulate to a member of the subgenus Cephaloxys while my observations were made upon a species belonging to the subgenus Strumigenys. I am ready to agree that the habits of the two groups may differ but I would incline to the view that of the two Cephaloxys might be expected to show more nearly general feeding habits than Strumigenys. The mandibles of most species of Cephaloxys are far less aberrant than those of Strumigenys and, in addition, the workers of Cephaloxys forage outside the nest in a perfectly normal manner. I have been able to observe this forraging in the case of three species of Cephaloxys and do not doubt that the other members of the group behave in a similar fashion. On the other hand I have never seen a worker of the subgenus Strumigenys outside the nest although I have taken these insects in several localities. There is, perhaps, little need for such elaborate refutation when it can be stated that the members of the captive colony readily fed on the tissues of other insects or, when these were not available, on a mixture of egg yolk and sugar. They refused sugary foods containing little protein. Indeed they were the first ants which I have ever known to reject a diet of bananas. With these observations in mind it seems to me that one cannot escape the conclusion that under natural conditions Strumigenys is insectivorous.[1]

---

[1] After this article had gone to press the author received from Mr. L. G. Wesson, Jr., a most interesting paper describing his studies on the feeding habits of *Strumigenys pergandei*. (Entomological News,

We now come to another postulate concerning the habits of Strumigenys which was advanced by the author in a paper published in 1930 (4). This publication, primarily concerned with the genus Myrmoteras, carried introductory remarks on various genera possessing linear mandibles. The matter of retrosalience was necessarily discussed but I attempted to show that this phenomenon represented the fortuitous outcome of a type of mandibular organization which I styled "trap-jawed". I pointed out that such mandibular apparatus would be a very decided advantage to sluggish ants enabling them to capture other insects more agile than themselves. It is gratifying to be able to state that this supposition has proven correct in the case of Strumigenys. Because much of what is to follow presupposes a knowledge of the structure of the mandibles of Strumigenys I have prefaced the account of their activities with the needful morphological description.

Each mandible of *S. louisianae* subsp. *laticephala* (Fig. 1) is inserted close to the midline of the head and consists of a rather stout blade which is rounded on the outer face and flattened on the inner. This blade bears two prominent apical teeth and a third subapical tooth which is about half as long as the other two. All three teeth are sharp and slender and set at right angles to the long axis of the blade. As the tip of the blade is somewhat rounded at the rear of the two apical teeth the resulting structure is not unlike what would be produced if the tines of a fork were bent at right angles to the handle. There is, however, this difference, the "fork" has only two tines and these are separated by the thickness of the blade of the mandible. There is thus a considerable space between the apical teeth, a fact which will be later shown to be of importance. When in repose the mandibles can be brought close together so that their inner faces are almost in contact. This appears to be the usual

---

Vol. 47, No. 7, pp. 171-174, 1936.). Mr. Wesson showed that the normal food of this ant consists of various species of springtails. The Collembola are hunted down by the ants but not seized until they blunder into the open mandibles of their captors. Mr. Wesson considers that the presence of various species of Strumigenys in the nests of other ants constitutes what he calls a "loose form of symbiosis." The Strumigenys benefit because of the abundant supply of springtails and are tolerated by the other ant which may benefit by the removal of the springtails.

position of the mandibles. I am by no means certain that the inner faces ever actually come in contact with each other although it seems likely that such contact may follow the snapping together of the mandibles during an attack. When the mandibles are held in the position just described the apical teeth lie close together and parallel to each other with their tips extending beyond the inner border of the opposite mandible (Fig. 2). If one looks down the long axis of the closed mandibles the four apical teeth may be seen to enclose a diamond-shaped area whose size will depend upon the degree of closure of the mandibles (Fig. 3). The mandibles can be opened to an astonishing extent, their outer borders approaching the sides of the head under extreme conditions. As a rule, however, they are not opened so widely, their usual position during attack being approximately at right angles to the long axis of the head. Under such circumstances the trigger hairs may be readily seen (Fig. 4). These do not arise from the mandibles themselves, as is the case with other forms possessing similar gnathal apparatus, but are borne on two conical lobes which lie between the bases of the mandibles. The trigger hairs are about two-thirds as long as the mandibles, and, since they project forward, it may be readily seen that objects which they touch should lie within the arcs described by the closing jaws. Anyone familiar with the mandibular organization of Odontomachus or Anochetus will recognize the essential similarity of the structures just described in Strumigenys. Since we know that Odontomachus is able to dismember other insects with its pincer-like mandibles it seems reasonable to expect analogous reactions in the case of Strumigenys. My observations have supported this expectation but it must be borne in mind that the exceedingly deliberate actions of Strumigenys result in a type of attack which appears very different from the energetic activities of Odontomachus.

As soon as the colony had recovered from the shock of transplantation and seemed at home in its new surroundings I cast about for a suitable victim with which to test the idea just mentioned. The small size of the Strumigenys worker considerably limited the choice. I wished to have the victim a more active insect than the Strumigenys and prudence forbade the use of any form which might possibly damage the

Strumigenys during the attack. With these points in mind I selected *Brachymyrmex heeri* var. *depilis* as most suitable although under natural conditions it may be doubted if the two species often come in contact. For my purposes the choice was a most satisfactory one for each of the thirteen Brachymyrmex workers introduced into the nest was killed by the Strumigenys although some of them managed to avoid death for a number of hours. The method of attack employed by the Strumigenys was remarkably constant, so much so that I feel it unnecessary to cite individual cases unless there is some point of special interest.

The sequence of events was as follows:

On admitting the Brachymyrmex to the nest it began a series of exploratory investigations during which it visited the various nest chambers. As the Strumigenys preferred to stay in one of the narrow passages connecting two of the chambers it frequently happened that the Brachymyrmex actually ran over the quiescent Strumigenys workers. The latter roused at once and opened the mandibles but it seldom happened that any of them struck at the Brachymyrmex at that time. It may be added that, until it was attacked, the Brachymyrmex showed little fear of the Strumigenys. After becoming aware of the presence of the Brachymyrmex the Strumigenys workers would begin to move slowly about the nest. It is hard to depict the extreme deliberation of their movements. They proceed literally a step at a time and this gives to their actions an air of stealth which is probably spurious since they never move rapidly under any circumstances. Eventually one or more of the Strumigenys workers would approach within striking distance of the Brachymyrmex. If the latter were quiet the attacker would locate its position by cautious explorations with the antenna before it struck. Not infrequently, however, the Brachymyrmex blundered into the open jaws of the Strumigenys which were promptly snapped shut as the trigger hairs were touched. The closure of the mandibles is extremely rapid and is followed by a distinct backward jerk of the body of the attacker. These two movements seem to be the only rapid motions of which the Strumigenys worker is capable. The effect of the attack on the Brachymyrmex is very marked. It would at once begin an elaborate series of cleaning reactions involving the antennal funiculi, the fore legs and sometimes the tip of the gaster. A single injury such as might have been received from the mandibles of the attacker would scarcely be expected to evoke such a general response. Moreover, as I shall presently show, injuries are rarely sustained by the Brachymyrmex during the initial attack. Yet this cleaning reaction after the attack is an exceedingly constant one. I observed it so often that I am led to suspect that some irritating substance is ejected by the Strumigenys at the moment of striking. I much regret that I cannot prove this point which is very interesting if true.

While the Brachymyrmex was busy cleaning itself other Strumigenys workers would arrive and encircle it. Although the advantage of a concerted attack would seem obvious I never saw this happen. Each Strumigenys attacks separately moving in with great deliberation and ascertaining the position of the Brachymyrmex with the antennae before striking. It is interesting to note that this particular reaction prevents the Strumigenys from striking each other. Quite frequently the positions of the attackers would be such that they would have struck one another had they relied solely upon the trigger hairs to release the mandibular mechanism. By bringing the antennae into play they were enabled to recognize their nest mates and would alter their position accordingly. In the hundreds of times which I witnessed the Strumigenys attack I never saw one strike a nest mate. During this phase of the attack the Brachymyrmex would, of course, be struck at repeatedly. Not infrequently it would break out of the circle of attackers and run to another part of the nest. This, however, merely delayed the final result for sooner or later it was again surrounded. After the Brachymyrmex had been struck at perhaps twelve or fifteen times it usually became much dejected. It ceased the cleaning movements which it had continued up to this time and made no further attempts to avoid attack. I wish to stress the fact that this dejection, if I may use that term, was not due to injuries. Except in rare cases the Brachymyrmex would reach this stage of the attack without any visible sign that it had sustained damage from the mandibles of its attackers. The change in its reactions was, nevertheless, most pronounced and this again leads me to the conclusion that its lethargic condition may have resulted from the cumulative effects of some substance ejected upon it by the Strumigenys.

With the decreasing activity of the Brachymyrmex the Strumigenys became, if possible, more methodical than ever. They would deliberately manoeuver the mandibles so that they would close on a leg or antenna of the victim and the better success of this attack was evidenced by the appearance of injuries in the parts just mentioned. The distress of the Brachymyrmex was now very apparent. It would undergo spasmodic shudderings or lift its body as high as possible with the legs stiff and straight beneath. As a rule it lost the power of muscular coordination a short time afterward and the attack would end with the Brachymyrmex lying on the floor of the nest with its legs drawn tightly beneath it.

In most cases the Strumigenys would later carry out the corpses of their victims and deposit them on the "kitchen midden", in this case one of the food chambers of the nest. I was thus enabled to relax the remains of the Brachymyrmex workers and study the extent and character of the injuries. As might have been expected these were remarkably uniform. The antennal funiculi suffered the most. One or both usually showed injuries involving the loss of several joints. Not infrequently the entire funiculus, except the basal joint, was missing. The fore and middle tarsi, while less frequently damaged than the funiculi, were often injured. The hind tarsi were usually intact. In one specimen the tip of the gaster was torn but this injury was so slight that I would probably not have noticed it had it not been for the actions of the ant while it was still alive. This was the sole injury involving the body of the victim. Although I made a most careful search for evidences of piercing on various parts of the body I never found the slightest indication that the teeth of the attackers had penetrated the integument of the Brachymyrmex. As it would be hard to find an ant in which the integument is softer or thinner than that of Brachymyrmex the lack of body wounds can scarcely be attributed to the inability of the Strumigenys to pierce the chitin. On the contrary it seems obvious that they make little effort to do so preferring rather to cripple the victim by removing the joints of the appendages. While this view checks with observed facts it is far from satisfactory as an explanation covering the death of the Brachymyrmex. We may admit that most ants are severely affected by injuries involving the antennae but it rarely happens that such injuries are immediately followed by death. The loss of a tarsal joint or two is usually a matter of slight consequence. Yet in thirteen cases injuries of the nature just described were accompanied by the rapid demise of the victim. Again I find myself led to the view that some substance is ejected by the Strumigenys as they strike at the victim. It would seem necessary to believe that this substance is not only irritating but toxic. Again I must stress the fact that I cannot prove this assumption. It is, however, the only explanation which appears to cover the facts.

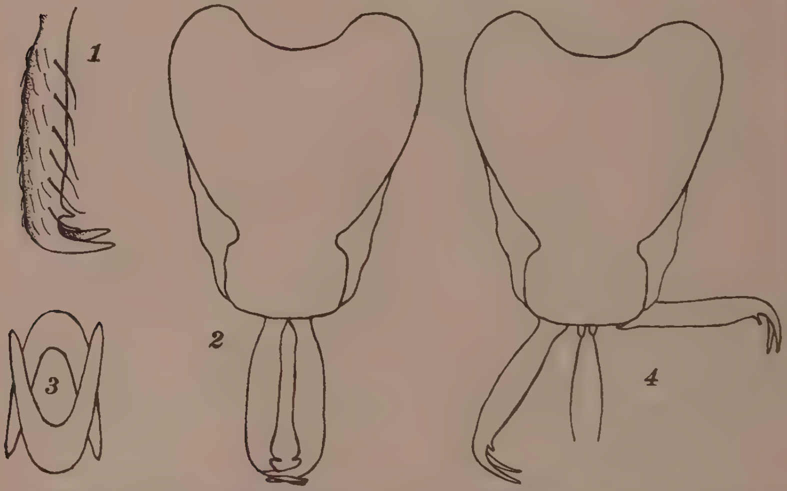

Fig. 1. Cephalic structures of *Strumigenys louisianae* subsp. *laticephala* Smith. For explanation of figures see text.

I wish to add a few more observations concerning the manner in which the Strumigenys workers use their mandibles. The first of these involves a detailed discussion of the role of the mandible during attack, a matter which is more complex than might be supposed. The extreme rapidity with which the mandibles are closed in striking makes this process very difficult to follow. Repeated observations have, however, convinced me that the mandibles of Strumigenys, unlike those of Odontomachus, do not act as shearing organs. I have already pointed out that each time a Strumigenys worker strikes at a victim the closure of the mandibles is immediately followed by a backward jerk of the insect. At first this used to annoy me considerably since it seemed to defeat the whole plan of attack by moving the Strumigenys out of range. I later learned to appreciate the vital part that this sudden backward motion plays in the amputation of appendages on which the mandibles close. It may be readily observed that when the Strumigenys workers close in for the final attack the damages to the antennal funiculi and tarsi of the victim involve mangled joints. The portion of the appendage beyond the injured joint will often bend in a fashion which plainly indicates that the joint has been badly crushed. As a rule the part of the appendage beyond the damaged joint is quickly removed as the result of further attacks. As its final removal is accomplished with the speed of a conjuring trick it was some time before I realized exactly how this is done. It is obvious that the initial damage to the appendage is caused by the flattened inner faces of the mandibles of Strumigenys which crush the joint on which they close but lack the power to completely sever it. I have already pointed out that in repose the mandibles of Strumigenys do not quite meet and this may account for their deficiency as pincers. It might be supposed that the backward jerk which follows this initial damage would sever the appendage but this is not usually the case. I believe that this can be explained if we consider that the crushed joint is free to move along the approximated inner faces of the mandibles which are smooth and without teeth except for the three at the apex. As I have already stated the final removal of the distal portion of a damaged appendage is a very speedy process and I am by no means certain that the method which I am about to describe is invariably employed. There has been ample opportunity, however, to observe that it is frequently used. It involves a relation between the appendage and the mandibles such that the four apical teeth close around the appendage. Because of the shape of the space included between these apical teeth (*vide supra*) they can lock against the appendage. This is particularly true if the latter happens to be an antennal funiculus which increases in diameter toward the tip. The backward jerk of the Strumigenys is then exerted in the direction of the long axis of the already injured appendage which may break in consequence at the damaged joint. It may be added that unless the appendage has been previously crushed it cannot be pulled off when caught by the apical teeth. Under such circumstances there ensues a sort of a tug-of-war with the Strumigenys holding grimly to the appendage and the victim struggling frantically to get free.

Aside from their vital role in attack the mandibles of Strumigenys are little used. They occasionally employ them in carrying nest mates about but this was seldom observed. I never saw any indications that the mandibles play a part in the trophic reactions of these insects. Feeding is entirely cared for by the palps and other mouthparts. When Strumigenys is feeding the mandibles are kept closed and thrust upward over the food until the stubby palps come in contact with its surface. The palps apparently act both as rasps and spoons for both liquids and semisolids are ingested by their help. The feeding reactions of Strumigenys are exceedingly difficult to follow because all the more delicate mouth parts are reduced in size and closely packed into the small buccal cavity. It is interesting to note that the mandibles are kept closed during regurgitation. This results in a rather awkward situation for both regurgitant and recipient. The closed mandibles prevent the usual approximation of the two heads and it is only after considerable preliminary fencing that the correct posture is assumed. Each ant turns its head sidewise so that ventral surfaces are parallel although not opposite. The closed mandibles are then crossed and slid over each other until the palps are close enough for the transfer. It seems a remarkably clumsy way of securing a result which could be easily reached by simply opening the mandibles.

There remains the matter of retrosalience. I saw this phenomenon only twice during the many hours that the captive colony was under observation. In one case it resulted when the mandibles of an attacking Strumigenys worker closed on the convex surface of a glass tube which led to one of the feeding chambers. The resulting leap threw the insect against the top of the nest whence it was deflected to the floor at a point not much more than three-quarters of an inch from its original position. Had the leap been unimpeded it would probably have been more extensive. The second case occurred under similar circumstances and with much the same result. As far as I am aware this is the third time in which retrosalience has been reported for a member of the genus Strumigenys. Hetschko (*teste* Mayr) observed it in the South American *S. saliens* about 1887 (5) and ten years later Biro (*teste* Emery) saw the same phenomenon in the case of *S. chyzeri* which he studied in New Guinea (6). Each of the above accounts is rather meager but it seems likely that both species frequently resorted to retrosalience. It is not impossible that it had come to play a protective role in their habits as is the case with Anochetus and Odontontomachus. I cannot believe that retrosalience plays any such part in the case of *S. louisianae*. The phenomenon is so rare and the conditions which would produce it so unusual that it must play little or no part in the ecology of this form.

LITERATURE CITED

1. Smith, M. R. Ann. Ent. Soc. America. Vol. XXIV, No. 4, p. 690, (1931).
2. Kennedy, C. H. & Schramm, M. M. Ibid. Vol. XXVI, No. 1, p. 104, (1933).
3. Wheeler, W. M. & Bailey, I. W. Trans. American Philos. Soc. N.S., Vol. XXII, No. 4, p. 247-248, (1920).
4. Creighton, W. S. Jour. New York Ent. Soc. Vol. XXXVIII, p. 177, (1930).
5. Mayr, G. Zool-bot. Ges. Wien Vol. XXXVII, p. 575, (1887).
6. Emery, C. Term. Füzetek, Vol. XX, p. 576, (1897).

CANNIBALISM AMONG LEPIDOPTEROUS LARVAE

V. G. Dethier

Biological Laboratories, Harvard University

The occurrence of the carnivorous habit in lepidopterous larvæ is known in certain rather widely separated groups, one of which, the Lycænidæ, is outstanding (Brues, 1936). It is known also that some phytophagous larvæ will become carnivorous for a period of time either regularly or in the absence of a plentiful food supply (Brues, 1920). I have observed this and also cannibalism many times while breeding various species.[1] A few examples may be cited.

When larvæ of the Arctiid, *Apantesis arge* Drury, were confined to a limited area (three to four larvæ to eight square inches) with a moderate supply of food, the smallest, least healthy, or least active larva was usually attacked while still alive and almost entirely eaten by a more robust specimen. Fifty of these larvæ were divided into lots of two, three, and four, each lot being limited to an area of eight square inches. In nearly seventy-five percent of all cases cannibalism occurred. It was noted more frequently when four larvæ were confined together or when one larva was smaller or weaker than its neighbors, as stated above. Moore (1912) reported that *Phœbis eubule* L., when confined even in the presence of an ample food supply, ate smaller larvæ of its own species. The more aggressive individuals also devoured the more peaceful ones. Perkins (1928) found that *Nemoria viridata* L. in the presence of an abundance of food also showed cannibalistic tendencies. The larvæ from a large batch of eggs feasted upon one another till there was but one left. This animal pupated and a normal adult emerged. Subsequent breedings with other batches of eggs of the same species revealed no further cases of cannibalism.

I have observed that larvæ of *Estigmene acræa* Drury and *Diacrisia virginica* Fab. when confined with those of other species, notably *Papilio polyxenes* Fab., *P. philenor* L., and *Danaus plexippus* L., in ample space but with a limited food supply, readily attacked and ate pupating larvae and chrysalids of the butterflies. They also ate pupæ of their own species, devouring all the hair and silk of the cocoon as well. *Papilio philenor* L. speedily attacked chrysalids and pupating larvæ of its own species as soon as the food supply dried up or diminished. This has also been reported by Clark (1925) as occurring in *P. polyxenes* Fab. and *Danaus plexippus* L. Orfila (1927) reported that *Ecpantheria indecisa* Walkr. in the presence of an abundance of food devoured chrysalids of *Tatochila autodice* Hb. and also the parasites (*Apanteles sp*?) with which the chrysalids were infected.

---

[1] For cases of oöphagy see Schultz (1928, 1935).

The most striking example that I observed was the case of a noctuid, *Autographa sp*?, which attacked other larvæ of its own species although plenty of food was available. It is interesting to note that this noctuid also fiercely attacked healthy and active larvæ of *Danaus plexippus* L. and *Malacosoma americanum* Fab. While the victim struggled the noctuid stood upon it and chewed its way rapidly into the flesh.

Bell is quoted (de Niceville 1901) as being of the opinion that a larva will never eat another larva feeding on a food plant different from its own. He also advanced the idea that "—cannibal larvæ are hardly conscious that they are eating up each other, being only guided to their proper food by the sense of taste, or possibly to a less extent by the sense of smell". The noctuid referred to above could not be induced to feed either upon cherry (the food plant upon which *M. americanum* was feeding) or upon milkweed (the food plant of *D. plexippus*) although it would feed upon other plants. The question had been raised by Bird (1925) as to whether or not the food plant imparted a flavor to larvæ which was repellent to internal parasites (the conditions would be the same in the case of cannibals). Whether or not this is the case can not be definitely stated at the present time. Undoubtedly the gut of the larva attacked would, if it contained food, taste of the food plant which had been eaten. It appears unlikely that the cannibal larva would be able to distinguish its prey before it had attacked it, and, therefore, should, theoretically, *attack* any larva regardless of what it had eaten.

v. Roesel v. Rosenhof (1749) reported that *Chariclea delphinii* L. frequently ate larvæ of its own species. *Calyminia trapezzina* (L.) and *Agrotis ypsilon* (Rott.) have been reported to be cannibalistic by Berg (1875, 1892). Lederer (1932) reports the case of a noctuid, *Scopelosoma satellitia* L., attacking and eating the posterior end of its own body. It is known that some larvae when injured in this region of the body will devour themselves. Schultz (1935) reports that the following larvæ ate chrysalids of their own species: *Acidalia herbariata* F., *Eupithecia castigata* Hb., and *Dianthœcia capsincola* Hb. He further states that Arctiidæ commonly nibble at chrysalids and that *Caradrina exidua* is cannibalistic.

Mr. C. M. Williams (unpublished data) noticed that when *Hæmorrhagia thysbe* Fab. larvæ were crowded some would attempt to eat others. He also noticed when many *Telea polyphemus* Cramer larvæ were crowded in confinement with an ample supply of their food plant that certain individuals attacked others and succeeded in breaking through the integument. In neither case, however, was the attack carried beyond this point.

Another interesting case is that of a larva of *Epizeuxis lubricalis* Geyer which I observed devouring a considerable portion of the wings of a dried *Colias philodice* Godart contained in the same collecting box. The caterpillar then proceeded to build a cocoon with what remained of the butterfly.

While this last case should really be classed as saprophagy, it should be noted that the remaining cases of cannibalism occurred under laboratory conditions rather than in nature. The reversion to a meat diet in many cases seemed to follow conditions of crowding or of lack of sufficient food. The following cases, especially the first, are offered to show that similar conditions can and undoubtedly do prevail in nature.

From October eleventh to November third 1937 I observed (Dedham, Mass.) an immense swarm of the larvæ of *Isia isabella* Smith & Abbot which was estimated at not less than one hundred thousand. One could collect five hundred of these larvæ in three minutes without visibly decreasing the hordes covering the ground. The area thus overrun was marsh land, approximately half a square mile in extent, cut from north to south by a river, and bounded on all sides by highways. The larvæ were found only on the east side of the river. Of the thousands which were traveling back and forth between the river and the highway many were killed by passing vehicles and pedestrians. Practically every fifth caterpillar that had been killed was being eaten by one or more of the same species which were consuming all parts of the dead ones, except the hairs. The green vegetation in the vicinity was restricted to a narrow belt along each side of the highway. The scarcity of low-lying vegetation was evident. Practically the only green plant was an aster, *Aster lævis,* growing to a height of four feet. The larvæ which were not feasting on the dead specimens were eating the tops of the asters. Feeding on tall vegetation is unusual for a characteristically ground-loving species like *Isia isabella.* It is noteworthy that nearly all the larvæ showed signs of hunger. It would seem that the summer of 1937 was for some reason especially favorable to the development of this species. With the approach of autumn the supply of food plants in the area to which the caterpillars were confined gave out in the presence of such overwhelming numbers. The larvæ were prevented from traveling west by the river, hence they swarmed upon the highway where they were killed in large numbers. The hungry survivors either feasted upon the dead or climbed the asters. No cannibalism was observed in the few individuals of *D. virginica* and *E. acræa* which were also present.

On the occasion of an exceedingly large swarm of *Ecpantheria,* Orfila (1927) noticed three animals avidly devouring the remains of a fourth which was still living.

The following are also said to be cannibalistic in nature: *Laphygma frugiperda* Smith & Abbot (Moore 1912), *Vanessa caryæ* Hb. (Berg 1875, 1892), and *Heliothis obsoleta* Fab. (Berg 1875, 1892). Berg reported that *H. obsoleta* ate from six to seven larvæ in twenty-four hours.

The question as to why larvæ show cannibalistic tendencies is a difficult one to answer. Three alternative solutions have been suggested by Orfila (1927): 1) it is due to an internal physiological cause, 2) an organic disarrangement produces an alimentary upset, 3) cannibalistic manifestations herald a return to a past carnivorous diet. Orfila believes that the original diet was vegetable, and while he points out that sporadic cannibalism may be the forerunner of a more widespread carnivorous diet in the future, he leans toward the belief that cannibalism is due to an upset in internal organic conditions. Berg (1892) maintained that climatic conditions (in Patagonia) caused the supply of food plants to diminish so that larvæ were driven to cannibalism by hunger. This is undoubtedly correct. He further maintained, however, that the cannibalistic character was inherited, and that many larvæ could not return to a vegetable diet after having eaten meat. It is not improbable that natural selection could be responsible for the high percentage of cannibalism found in many species. I have observed, however, that our native species will return to a vegetable diet if given the opportunity. Schultz (1935) is of the opinion that cannibalism may be due not only to hunger but also to a need for satisfying thirst. Without a doubt thirst is a contributing factor. This much may be said, that cannibalism may be induced experimentally by crowding and by an insufficient food supply, but that it appears to crop out under conditions of favorable population densities and food supply as well. It is not improbable that this phenomonon will be found to be more widespread in lepidopterous larvæ than is realized at the present time. Thus far cannibalism has been reported in Geometridæ, Noctuidæ, Arctiidæ, Saturniidæ, Bombycidæ, Sphingidæ, Danaidæ, Nymphalidæ, Papilionidæ, Pieridæ, and Lycænidæ. It does not appear, however, that larvæ are forced to adopt a meat diet under favorable conditions but simply do so accidentally when in close proximity to another individual. Or, they may attack when unduly disturbed, and having tasted meat, continue to eat more or less automatically as long as its taste is not repellent. Larvæ taken off a meat diet will survive with no apparent ill effects on a normal vegetable diet.

LITERATURE CITED

Berg, C., 1875. Patagonische Lepidopteren. Bul. Soc. Imp. Nat. Moscou, 49(2): 191-193.

——— 1892. Canibalismo entre insectos. Anal. Soc. Cient. Argentina, 34: 386-388.

Bird, H., 1925. New life histories in Papaipema No. 23 (Lepidoptera). Canadian Ent., 57(12): 305.

Brues, C. T., 1920. The selection of food plants by insects, with special reference to lepidopterous larvae. American Nat., 54: 313-332.

——— 1936. Aberrant feeding behavior among insects and its bearing on the development of specialized food habits. Quart. Rev. Biol., 2(3): 305-316.

Lederer, G., 1932. Tiere, die versuchten, sich selbst aufzufressen. Int. Ent. Zeit., 26(2): 28.

Moore, H. W. B., 1912. Ways and habits of caterpillars. Timehri, 2(1): 197, 198.

de Niceville, L., 1901. Cannibalism among caterpillars. Canadian Ent., 33(5): 131, 132.

Orfila, R. N., 1927. Sobre canibalismo en insectos. Rev. Soc. Ent. Argentina, 2(4): 65, 66.

Perkins, R. C. L., 1928.
Proc. Ent. Soc. London, 3(1): 20.

v. Roesel v. Rosenhof, B., 1749. Insektenbelustigung Zweyte Classe der Nachtvögel, p. 82.

Schultz, V. G. M., 1928. Taeniocampa populi Ström. (= populeti Fr.) Int. Ent. Zeit., 21(46): 439-442.

——— 1935. Lepidopterologische Beiträge. Einige Fälle von oophagem und chrysalidophagem Kannibalismus bei Grossschmetterlingsraupen. Int. Ent. Zeit., 28(41): 501-504, 556.

A MEGAMORPHIC AND TWO CURIOUS MIMETIC FLIES

By Frank M. Hull

University of Mississippi

At a recent visit to the Carnegie Museum the writer was afforded the privilege of studying the unidentified Syrphid flies in the collections. Among this material were discovered certain curious types upon which it is desired to report at this time. The bulk of the material will be reported upon later. I wish to express my thanks to Dr. Hugo Kahl for the opportunity to study this material.

Chysidimyia, new genus

Eyes bare. Antennæ slender, third joint densely erect pubescent, the dorsal arista thickest in the middle. Whole face extended as a rounded lump anteriorly, a crease separating the lower face from the upper, and lying shortly above the oral margin. Antennæ inserted from ventral surface of an overhanging frontal shelf. Scutellum with two spines, moderately separated. Abdomen oval-elongate; the sides of the second segment greatly thickened and overlapping the corners of the succeeding segment making possible a downward deflection of the remainder of the abdomen. Whole lateral margins of the abdomen enormously thickened and inrolled; segments three, four and five entirely fused. Legs simple, an oblique groove on the basal part of hind femora.

Whole head, thorax, abdomen and legs everywhere brilliant metallic green and extraordinarily deeply punctate. The punctures are actual depressions, which on the posterior rim of the second abdominal segment, become grooves.

Wings with the posterior angles of the first posterior and discal cells rounded, that of the first posterior gives off a spur to wing margin. There is a spur cutting down towards the spurious vein from the third longitudinal vein.

Genotype: *Chysidimyia chrysidimima* new species.

Chysidimyia chrysidimima new species

Eyes nearly touching, approaching in an angular fashion which is but little over a right angle, perhaps 110 degrees. Eyes quite noticeably short, whitish pilose. Vertex swollen, the eyes gradually excavated behind so that the occiput and post vertex is for some distance rounded and enormously thickened. Ocelli inserted at highest point, some distance from post occipital margin and almost midway from antennae. Antennæ situated a little above midline of profile, to the lower surface of a slight shelving prominence. The face below antennæ slightly excavated for a short distance, then swelling to large rounded mammiform area and falling off just a short distance before the oral margin, not right at the margin. A marginal crease delimits the very small cheeks. Lower occiput very thin. There is a vertical crease down the midline of face. Antennæ elongate, black, the first joint as long as the third; the second one-fifth or one-sixth of the third. The third is thickest just before the rounded apex. The arista is basally thickened, shorter than third and black and bare. Pile of face, except for a few dark hairs on front, whitish. Whole face and head everywhere deeply and remarkably punctate.

Pile of thorax quite short, very appressed, black with a few pale hairs. Scutellum armed with two short spines set slightly closer than length of scutellum in midline.

Abdominal pile short, scanty, appressed, black with a few pale hairs and in the margins more pale hair. The greatly thickened tergites at the sides are inrolled and the apical margin of the second segment is greatly thickened and equipped at the corners to overlap the rest of the abdomen in down folding.

Legs black, the terminal tarsal joints dark brown; the tibiae and femora metallic green, with small punctures; the hind basitarsi not extraordinary, nor the hind femora greatly thickened. Wings grey, terminal section of fourth longitudinal vein straight, a spur dropped from third longitudinal vein into the first posterior cell. Spurious vein present.

Length 9 mm.

One male. Santarem, Brazil, June 1919. (S. M. Klages). Accession 6324. Type in the Carnegie Museum.

The whole insect is remarkably brilliant blue-green, metallic, vitreous, covered everywhere with deep punctures or pits, and on the abdomen small creases, in shape and appearance presenting an astonishing resemblance to a *Chrysidid* wasp, altogether the most remarkable case of mimicry I have ever beheld.

Tityusia new genus

Large flies, the males narrowly holoptic, the upper facets slightly enlarged, the antennal prominence well developed, the antennæ have the third joint suborbicular and the arista bare. First and second joints short. Face with a very low median tubercle, not greatly produced either anteriorly or ventrally. Post-occiput flared posteriorly backwards about central opening, and long pilose.

Thorax and scutellum normal, with very dense pile of median length, the rim of the latter simple. Metanotum with a horizontal depression or crease. Abdomen broadly oval, broad basally, tapering posteriorly, yellow maculate somewhat similar to species of *Helophilus* and *Mesembrius*.

Hind femora moderately thickened, but unarmed posteriorly with either spines or setae. The black basal patch of setulae present. Anterior femora greatly thickened, especially apically and from the apical third of the posterior margin a very thick brush of dense dark pile is sent backward, much as if the hairs of a brush had been wetted. Fore tibiæ still more extraordinary, enormously thickened, grooved, twisted and distorted, the median and lateral edges bare, dense fringes of dark pile extremely long, extremely matted, directed backward. Fore tarsi extravagantly flattened on the dorso-ventral axis, the lateral edges of the second, third and fourth segments prolonged into narrow down curving lobes. Median pair of legs simple, except that their tarsi are flattened somewhat. Posterior tibiae slightly flattened. Posterior basitarsi nearly as long as post tibiae, on its distal end bearing an enormous brush of dark matted hair, its basal end equipped with the characteristic globuliferous hairs of *Mesembrius*. Marginal cell of wings narrowly open. Halteres long stalked, the knob with a deep cup shaped depression. This may be due to drying.

Genotype: *Tityusia regulus* new species.

Tityusia regulus new species

Male. Eyes bare, touching narrowly. Vertical triangle quite narrow. Frontal (antennal) prominence well developed, shining brownish black. Face and cheeks similarly colored, the former light yellow on the sides and covered with pale yellow pubescence and similar longer pile, the pubescence being sparse on the weak low tubercle. Pile of front and vertex black, of occiput above and below, long and pale golden in color. Antennæ and arista dark brown.

Thoracic dorsum black, opaque or at best subshining, an obscure yellowish pollinose stripe on the middle of either side, and even more obscure and narrower vitta lying on the midline. Anterior three-fifths of dorsum clothed with dense moderately long, pale golden pile, the tips of the hairs crinkled and a few very fine black hairs intermixed. The posterior part of dorsum, short, thick, black pilose, the scutellum golden pilose. All the thoracic pile very erect. The brown humeri largely bare, what pile is present (including humeri) is long, tufted, crinkled, and pale golden.

Abdomen: first segment, the fore and hind borders of second and a narrow median connection widening quickly in either direction, dark brown to black. A brown subshining apical band on the third segment with its fore border raised into a low acute pyramid, and a similar apical band on the fourth segment with a rounded fore margin that nearly reaches the base of that segment, also dark brownish black but shining as well. This leaves two very large orange spots, shaped like the ends of a parabola on the second segment and a similarly colored band at the base of the third segment. The base of the fourth segment is densely greenish yellow pubescent. Pile on the surface of the segments and in the middle, black and appressed becoming more erect, longer and golden in color on the sides. Some straggled, curious, long, flat, appressed golden hairs on base of the second segment.

All the legs dark brownish to black, subshining, the very narrow bases of tibiae pale, and the tarsi varying shades of yellow brown. Pile of femora, except anterior pair, long, pale, crinkly. That of hind tarsi, fore tibiae and fore femora a most extraordinary mat of dense, excessively long hair. Fore tarsi pale, flattened and laterally produced in an extravagant way, reminding one of *Platychirus*. See the generic description for further details.

Length 18 mm.

One male. Efufup, Kamerun, W. Africa, August 30, 1919. Carnegie Museum. Accession No. 6552. Holotype male in Carnegie Museum.

This fly is to the Syrphidae what *Calotarsa* is to the *Platypezidae*, a curious convergent type of structural development.

Syrphipogon new genus

Very large flies related to *Microdon*.

Eyes bare, broadly dichoptic in male. Antennae slender, the first joint sub-equal to last two. Arista thick, its surface pubescent. Hair of upper front directed upward, of vertex directed forward and upward so that the two converge above ocelli. Lower face just above mid oral margin equipped with a beard of long thick shining black bristles.

Thorax normal, thick black bristly, greatly appressed. Scutellum with a pair of enormous spines; deeply sulcate between, directed upward and posteriorward at an angle of 45 degrees. Abdomen broad and thick, the lateral posterior margins of the third segment and adjoining base of the fourth deeply sunken, followed by a simple situation on the next segment so that a strong ridge lies between. Hind basitarsi longer than remaining joints, greatly widened and flattened. Remaining joints similarly widened and flattened, but less so.

Last section of fourth longitudinal vein (subapical cross vein) bluntly angulate outward, just before terminus the posterior angles of the first posterior and discal cells not angulate but evenly rounded. No spurs except for the posterior cell spur cutting down to terminys of spurious vein. Wings black basally, blackish on a narrow distal apex, and yellow with yellow veins between.

Genotype: *Syrphipogon fucatissimus* new species.

Syrphipogon fucatissimus new species

Male. Whole face and head shining black, the face with a faint purplish tinge. Arista pale yellow. Antennae black, elongate. Last two joints about as long as first, not set on a pedicel. Third joint one and three-fourths times length of second. Second about equal width of front at narrowest point. Pile of head and face everywhere black, vertical pile and that of upper front converging to come together just above ocelli. Pile of upper face exceedingly appressed, black, bristly, the face punctate, developed on the lower face into a black beard of long bristles above oral margin.

Dorsum of thorax shining black, covered thickly with very short appressed bristles, a few golden ones on the sutures. Pleurae similar but with longer bristly pile. Scutellum developed into a pair of enormous black spines, deeply sulcate in the middle, and black bristly or pilose to their apices. Spines held at a forty-five degree angle.

Abdomen shining black, a deep excavation on the apical lateral half of the third and again on the fourth segments. Apical half of second segment long, golden pilose, a similar annulus or transverse band across the middle of the fourth segment so that the first excavation lies between and is black. Remainder of abdomen, except for a little more black following the second golden band, is deep bright orange reddish pilose.

Legs everywhere dark shining black, black bristly, the hind metatarsi (and the following ones to a less extent) enormously flattened and broadened, but not markedly thick.

Wings with basal half or three-fifths black, (very dark brown) the remainder except for light brown tip, yellow with yellow veins.

Length 25 mm.

South America, without further data. Type in the Carnegie Museum.

Curiously, this fly forms part of a three-part mimetic complex, the others being an Asilid fly and a bee from the same region.

WEST INDIAN CARABIDÆ IV: THREE NEW COLPODES

By P. J. Darlington, Jr.

Museum of Comparative Zoölogy, Cambridge, Mass.

Two of the following three new species were the chief prizes in a small but interesting lot of Carabidæ recently collected in the West Indies by Mr. Chester Roys. The third species was collected by myself in Haiti in 1934, but was only recently found to be distinct.

Colpodes sellensis n. sp.

Very Agonum-like (similar to *Colpodes agonellus* Darl., PSYCHE Vol. 42, 1935, p. 187); piceous brown, appendages not distinctly paler. *Head* slightly less than ⅔ width prothorax. *Prothorax* about ⅓ wider than long; base about ¼ or slightly less wider than apex; posterior angles rounded, although sometimes a little irregularly so. *Elytra* oval, with broadly rounded humeri. Inner wings vestigial, not reaching beyond middle of *second* ventral segment. Other characters as in *agonellus*. Length 7.5; width 3 mm. (slightly ±).

Haiti: *holotype* ♀ (M. C. Z. no. 23,013) and 1♂ 2♀ paratypes from La Visite and vicinity, Massif de la Selle, 5,000-7,000 ft. altitude, Sept. 16-23, 1934.

This new species differs from *agonellus* in having the prothorax narrower, with slightly narrower base and more rounded posterior angles; elytra more oval and with more rounded humeri; and wing vestiges shorter (in 70 *agonellus* with vestigal wings the tips of the vestiges reach to above, or rarely just beyond or just short of, the *third* ventral segment).

Colpodes bromeliarum n. sp.

Moderately elongate, somewhat flattened; shining blue, lower surface and appendages black, except legs bluish in some lights and antennae with segments 4-11 brown at sides.

Head elongate, about ¾ wide as prothorax; eyes prominent; genae long and oblique; 2 supraocular setae each side; antennae moderate, 4th segment 4 or more times long as greatest width; mentum tooth acutely triangular. *Prothorax* subquadrate, about 1/7 wider than long at middle (by measurement), very slightly narrowed at base, arcuately narrowed at apex; base truncate except slightly and broadly emarginate in median half, apex more distinctly emarginate; base about ½ wider than apex; sides arcuate in anterior half, very broadly and slightly sinuate in basal half, with margins moderately reflexed, each with seta at basal angle but without anterior lateral seta; basal and apical angles narrowly rounded; base and apex finely margined; disk slightly convex, with median line well impressed at middle, basal and apical transverse impressions less sharply defined; baso-lateral foveae moderate, extending forward supparallel to margins nearly to apex, finely punctate basally. *Elytra* about ½ wider than prothorax, slightly narrowed basally but with humeri about normally prominent; sides slightly sinuate before subindependently rounded apices; sutural angles subdenticulate; striae moderate, entire, punctulate; discal intervals slightly convex, 3rd tripunctate, anterior puncture attached to 3rd stria, others to 2nd stria. Metepisterna long, inner wings full. Lower surface impunctate except for traces of punctures at front of mesepisterna and 1st ventral segment. Tibiae not sulcate externally; posterior tarsi each with first 2 segments broadly and vaguely impressed or flattened each side, subcarinate at middle; front tarsi each with only basal segment thus modified; all tarsi of both sexes exceptionally wide and densely pubescent below; 4th segment posterior tarsus deeply emarginate, with outer lobe a little longer than inner; 5th segment without accessory setae. Male with 1, female with 2 setae each side apex last ventral. Length 10.5-13; width 3.7-4.4 mm.

Jamaica: holotype ♂ (M. C. Z. no. 23,014) and 7 paratypes from Swift River town, Portland, 1,000 ft. altitude, March 22, 1937; 2 paratypes from Bath, St. Thomas, Jamaica, 300 ft. altitude, April 3, 1937; all taken by Mr. Chester Roys. Some at least were in epiphytic bromeliads; the somewhat flattened body of the insect is probably an adaptation to life between the bromeliad leaf bases.

Related to *Colpodes punctus* Darl. and *bruesi Darl.*, both of Jamaica, but differs from *punctus* in metallic color and much less punctate lower surface, and from *bruesi* in punctulate elytral striae as well as in other details.

Colpodes roysi n. sp.

Moderately elongate, less flattened than *bromeliarum;* moderately shining dark blue, lower surface and appendages piceous except sides of antennal segments 4-11 brown. *Head* about ⅔ wide as prothorax, somewhat shorter than in *bromeliarum*, but similar in details of structure. *Prothorax* about 1/7 wider than long, strongly narrowed anteriorly, scarcely so basally; base nearly truncate, apex broadly emarginate; base about 3/5 wider than apex; sides broadly rounded in anterior ¾, faintly sinuate before approximately right, scarcely blunted posterior angles; margins moderately reflexed, each with seta at basal angle, without anterior lateral seta; base and apex finely margined; disk slightly more convex than *bromeliarum* but with similar impressions, baso-lateral foveae similarly finely punctate. *Elytra* about ½ wider than prothorax, slightly stouter and more convex than in average *bromeliarum* but similar in details of structure *except* apices each with a short spine opposite end of 3rd interval, and striae not distinctly punctulate. Metepisterna elongate, inner wings full. Lower surface without distinct punctation. Tibiae not sulcate on outer edge; posterior tarsi each with first 3 segments sulcate each side above and also vaguely sulcate at middle, so rather indefinitely bicarinate; front tarsi with basal segment vaguely sulcate each side and at middle; 4th segment posterior tarsi deeply emarginate, outer lobe somewhat longer than inner. Length 11; width 4 mm.

Jamaica: holotype ♂ (M. C. Z. no. 23,015), unique, from Bath, St. Thomas, Jamaica, 300 ft. altitude, April 3, 1937; from bromeliads, collected by Mr. Chester Roys.

Related to the preceding (*bromeliarum*) and more distantly to *punctus* and *bruesi*, but at once distinguishable by the spinose elytra, and differing in other less obvious details. The difference in tarsal sulci between this species and *bromeliarum* is surprising.

OBSERVATIONS AND EXPERIMENTS ON THE CASE-BUILDING INSTINCT OF TWO SPECIES OF TRICHOPTERA

By Manton Copeland and Sears Crowell

Searles Biological Laboratory, Bowdoin College,
Brunswick, Maine

The observations recorded here concern the case-building activities of two species of caddis fly larvæ. The first of these belongs to the Limnephilidæ, the other is a species of *Molanna*. Our interest in studying the case-building of these animals has centered around the experimental modification of the process, and we have endeavored to determine the extent to which this instinctive activity may be altered or adapted to changed conditions. Dembowski (1933) has made a very careful study of the case-building of *Molanna*, regarding this process as significant in indicating the plasticity of an animal's actions. Many papers on the case-building of caddis flies are to be found, but no others with this viewpoint. (See bibliography of Betten, Lloyd, or Greene and Milne.) Although our experimental work awaits completion, it has seemed proper to publish those observations which are believed to be new and which may be of assistance to others who are studying animal behavior or the natural history of the Trichoptera.[1] The various materials which these animals are able to use in the construction of the cases are described, as well as a few experiments in which there was an opportunity for the animals to use more than one kind of material, or to select the more appropriate one. The early steps in the formation of the cases are described in some detail. We believe no complete account of these has been published for any caddis fly larva except *Molanna*. This is unfortunate since this part of the process is the most difficult, and we have observed a greater difference in the method of procedure of different species at this stage than at any other.

---

[1] Since 1933 several authors have published comprehensive papers on Trichoptera as shown in the bibliography. In fact it was largely through the interest of one of these, Mr. Milne, that we undertook the publication of these observations made by us in 1930.

The limnephilid which we studied builds a case of the "log cabin" type, that is of small pieces of plant material placed transversely with respect to the long axis of the case. In studying the animals it was customary to push them out of their cases with a blunt needle and place them in a small dish with water and materials with which they might build a case. All of the materials mentioned in the accounts which follow which would not usually sink in water (e.g. paper and pine needles) were kept in it until they became waterlogged before being used.

The typical case-building procedure as observed in the laboratory is as follows. A larva, pushed from its case, is placed in a dish containing plant debris similar to that ordinarily used in its case. It crawls about for a time, then commences to gather bits of plant material beneath itself, holding them partly with its legs and partly by curling its abdomen downward. Soon, by employing a salivary secretion, it joins to one another the plant fragments that have been collected. In this way an irregular chain is formed composed of the pieces of building material. When the chain is of sufficient length the larva holds one end of it with the legs of one side and with a leg of the other side reaches around in back of itself for the free end of the chain. This is then drawn around to the ventral side and the two ends joined. The procedure is similar to that followed by a person in putting on a belt: he holds one end in front of himself and with his other hand reaches around in back for the free end which is then brought forward and fastened. In his account of the case-building of a caddis-worm, *Limnephilus flavicornis*, Gorter refers to this wrapping of the girdle around the larva in forming a "provisional case". He does not, however, describe the procedure.

The girdle formed of the chain of loosely-joined pieces constitutes the foundation on which the first part of the case proper is built. This girdle is held by the larva at the level of the metathorax and pieces of plant material are added, one at a time, to the forward edge.

The method of building the case from this point on has been described by others (See Lloyd 1921, Gorter 1929), and we have no new observations on this part of the process. Each piece of plant material is taken by the larva, smeared with the salivary secretion and set in place. As the case is extended, the original girdle and the completed part of the case are moved backward so that they cover the abdomen. The end to which new material is being added stays in the same position where it is easily reached by mouth-parts and legs. By the addition of material at the forward end the case is eventually completed.

Observations were also made on case-building in *Molanna*. Using sand grains these larvae build cases consisting of a central cylindrical tube, having at the anterior end a broad extension or overhanging hood that protects the animal from above even when its head and thorax are projected from the tube proper. This broad hood extends backward on either side of the main part of the case and forms lateral flanges possibly useful in preventing the case from rolling on its side.

The typical case-building procedure of a *Molanna* larva when pushed from its case and supplied with sand to the depth of about a centimeter is as follows. For about a minute the larva crawls about over the sand. It then curls its abdomen downward so that it no longer moves forward even though it continues to move its legs. This results in the digging of a slight pit in front of the larva and in the formation of a pile of sand beneath the body. Presently the head is forced down into the pit and turned underneath the pile of sand and underneath the body of the larva. Thus the animal is curled and lies on the back of its head as in the first step of a somersault. It then digs farther into the sand, joining the sand grains together loosely with the salivary secretion. Its head finally emerges at the surface on the side of the small pile of sand where the abdomen was located when the process began. The larva at this point has nearly completed a somersault and lies on its back in a sort of tunnel beneath the pile of sand. It next joins together the sand grains around the opening of the tunnel. When the sand grains which line the entrance to the tunnel have been firmly cemented together the animal is encircled by a firm girdle. As in the limnephilid, this is the foundation to which further building material is added to effect the completion of the case. In *Molanna* the girdle may be completed within fifteen minutes. It is clear that the formation of the girdle, the initial and most difficult step in case-building, is accomplished here by a quite different method than in the limnephilid.

The larva remains partly buried in the sand and by adding sand grains to the anterior edge of the girdle extends it to form a tube. This is similar to the method employed by the limnephilid in completing its case.

The hood which overhangs the anterior opening of the tube is constructed as soon as the latter is finished, but its backward extensions (flanges) on either side of the tube may not be completed for one or two days.

On several occasions a larva of *Molanna* was put into a dish with only a small amount of sand, that is with an amount insufficient to permit the burrowing and tunnel formation as described above. Under these circumstances the larva forms the girdle in a somewhat different manner, as follows: The larva collects sand grains into a small pile beneath itself. These are then joined loosely together by the salivary secretion. The larva then thrusts its head into this loosely aggregated mass of sand. If the sand holds together on all sides the larva thus surrounds itself with a girdle. Often the mass of sand breaks apart as the larva burrows into it. When this occurs the procedure is repeated.[1]

From this it appears that a *Molanna* larva, when there is only a small amount of sand, forms the girdle by burrowing, even though this is difficult and often unsuccessful. Since no attempt is made to form a girdle by wrapping the aggregated sand grains around itself, the method is not like that employed by the limnephilid, a procedure which might be more effective than the one actually used. It seemed to us that this method of girdle formation very closely resembled that employed by *Molanna* in deep sand, the only difference consisting in the cementing together of some sand grains before burrowing commenced.

It is well known that caddis-fly larvae are able to employ unusual materials in the construction of cases. We found that the limnephilid larvae were able to build cases of small bits of pine needle (*Pinus Strobus*), or in part of paper. The *Molanna* larvæ built cases of assorted debris when no sand was present; they built cases of both sand and plant bits when both were present; and were also able to make a case composed only of small pieces of broken glass.

---

[1] Dembowski (1933) reports one case in which a larva of *Molanna*, receiving an insufficient supply of building material, burrowed between the pile of material and the glass bottom of the dish, ultimately using the dish as the under side of its case.

The method of construction and the form of the case in all observed instances depends on the species rather than on the type or scarcity of material employed. Our observations lead us to regard the modification in the behavior of a larva when supplied with insufficient or unusual material as rather slight. The animal adheres as closely as possible to its usual method of case-building.

Dembowski, who studied only one species (*Molanna,* though probably not the same species as that used by us), emphasizes the variability and plasticity of the animals' activities under varied circumstances. Comparison of the behavior of various species, especially during the early steps of case-building when the larvæ work rapidly, leads us to regard the variations within each species as slight and of little significance.

A few tests were made with limnephilid larvæ to determine whether they would select short pieces of pine needles rather than longer ones which would require cutting by the larvae if they were to be used at all. In one test a larva with a case partly completed was given 50 bits of pine needle 3.5 mm. in length (about the length normally used) and 30 bits 11 mm. in length (a length greater than that of any of the pieces in any observed case built by larvae of this species). A few days later there were only 19 short bits left in the dish though 25 of the longer ones remained. The larva had certainly discarded the long pieces except in a very few instances. Since there were no long pieces in the case it is clear that the animal must have cut up the missing 5 long pieces. In a similar experiment performed later on the same animal 3 out of 25 short pieces were unused and 14 out of 15 long pieces were unused, that is, with but one exception, only the short pieces were accepted.

If a larva which has no case at all is given 11 mm. bits of pine needle it joins the pieces and forms a girdle but the structure is too cumbersome and inflexible to permit its being wrapped around the animal. The larva will again and again make the motions of wrapping the chain about itself, and failing will make another chain, or add to the same one and then again "endeavor" to complete a girdle. It does not, however, cut the pieces to a length which would permit their effective use. With 3.5 mm. bits a girdle may be completed. Larvae supplied with a mixture of long and short pieces use both to make the chain of material that precedes the formation of the girdle, but because this contains some long ones they are unable to wrap it around themselves to complete it. We found no evidence of a selection of material during the early steps in case formation when the length of the pine needle fragments was the only varying factor. Gorter (1929, p. 92) in the limnephilid that he studied observed that: "In the construction of the provisional tube all kinds of material were employed by the larvae, but the pieces could not be too large, for the larva did not bite the material into smaller pieces during the provisional building-process. Biting takes time and during the provisional building-process the larva makes the impression of being in a great hurry. Speed is the chief thing, not firmness, as with the final structure. . . ."

These observations clearly indicate that during girdle formation there is little or no selection and no cutting of materials, but that later when the case is partly completed there is both selection and cutting. However, if the choice during the early steps lay between flexible and stiff material the animals might have shown some selection, for Gorter (p. 92) observes: "In the provisional building-process one thing was very remarkable: there was a great preference for algae, a flexible and soft material, which can be quickly wrapped around the larva without being bitten off." We have not tested this point.

No thorough tests were made to determine whether *Molanna* would show selection of building materials during the early stages when it works rapidly. However, as the case nears completion and the animal works more slowly there is evidence of selection.

Examination of cases of *Molanna* shows that the sand grains of the tube are more varied in size than those of the flange and hood. The latter are nearly all relatively large grains. In one instance in which a larva had been supplied with a mixture of glass and sand the result was a completed case almost all of sand but with some glass in the older part of it. In another instance a larva was supplied with plant bits only. Using these it formed a case, complete except for the flanges on the sides. The animal remained in the dish with plant bits for two days. No pieces of material were added during the second day. On the third the larva in its case was put into a dish containing sand. It at once began to add sand grains at the anterior end, at first on the hood, then at the edge of the tube proper. By the next day quite a good deal of sand had been added at the anterior end though the main part of the case was of the plant bits. Further investigation, however, is needed to indicate clearly the extent to which *Molanna* selects appropriate materials at different stages in the process of case-building.

SUMMARY

1. The first steps in case-building, *i.e.*, the formation of a girdle, are described both for a limnephilid and for *Molanna*. The method is quite different in the two species.

2. Both the limnephilid and *Molanna* are able to employ a variety of unusual materials in the construction of their cases.

3. Even when supplied with insufficient or unusual materials, these caddis fly larvae build cases in close accordance with the method characteristic of the species.

4. In the limnephilid there is little evidence that the animals select the more appropriate lengths of materials during early steps of case construction. As the case nears completion, however, considerable selection does occur. Incomplete evidence is presented of a similar situation in *Molanna*.

BIBLIOGRAPHY

Betten, C. 1934. The Caddis Flies or Trichoptera of New York State. New York State Museum Bulletin. No. 292, pp. 1-576.

Dembowski, Jan. 1933. Über die Plastizität der tierischen Handlungen. Beobachtungen und Versuche an Molanna-Larven. Zool. Jahrb. Abt. allg. Zool. u. Physiol., vol. 53, pp. 261-311.

Gorter, F. 1929. Experiments on the case-building of a caddis-worm (*Limnophilus flavicornis* Fabr.) Tydschrift der Nederlandsche Dierkun dige Vereeniging. (3) vol. 1, pp. 90-93.

Greene, M. J. and L. J. Milne, in press. Immature North American Caddis Flies (Trichoptera). 1. A summary and extension of our knowledge of these forms.

Lloyd, L. T. 1921. The biology of North American caddis fly larvæ. Bulletin of the Lloyd Library of Botany, Pharmacy and Materia Medica. No. 21, pp. 1-124.

SYNONYMY OF THE GENUS PSEUDOXENOS SAUNDERS (STREPSIPTERA, XENIDÆ) AND RECORDS OF STYLOPIZED HYMENOPTERA FROM NORTH CAROLINA

By Richard M. Bohart

University of California, Berkeley

The genus *Pseudoxenos* was erected in 1872 by S. S. Saunders for parasites of the eumenid genus *Odynerus*. Further taxonomic work on members of the genus was done by Pierce, 1908, 1909, 1911, 1918; A. Ogloblin, 1924; Monod, 1925; and Esaki, 1932. Altho considerable information is available as a result of the efforts of these men, certain important characters of the female and first larva have been inadequately described.

Males, females, and first stage larvae of several undescribed species of *Pseudoxenos* are in the author's collection. From this material the following has been observed. In the male the anterior edges of the scutellum may be convergent or may be nearly parallel, thus invalidating the character used by Pierce, 1918, to separate the tribe Pseudoxenini from parasites of the Sphecoidea; the female has three genital tubes as do the parasites of Sphecinæ; and the first stage larva has five ocelli as in all the known strepsipterous parasites on wasps.

A careful comparison in all stages of these typical *Pseudoxenos* with specimens in the author's collection of the genera erected by Pierce, 1908, 1909, on the basis of host relationships and insufficient data; that is, *Leionotoxenos* from *Odynerus* and *Eupathocera, Ophthalmochlus, Homilops,* and *Sceliphronecthrus* from Sphecinæ, has failed to show any generic differences whatsoever. The characters used by Pierce, such as the shape of the scutellum and "consistency" of the postlumbium in the male, and shape of the cephalothorax and position of the spiracles in the female, vary widely and hence are useless.

Therefore, the author has come to the inescapable conclusion that the aforementioned genera are synonymous with *Pseudoxenos.* Altho no specimens have been examined of *Macroxenos* Schultze, 1925, from *Odynerus,* according to the description and figures this genus should also be referred to *Pseudoxenos.*

The following is a synopsis of the genus as herein redefined.

Genus **Pseudoxenos** Saunders, 1872

Eupathocera Pierce, 1908a; *Ophthalmochlus* Pierce, 1908b; *Homilops* Pierce, 1908c; *Leionotoxenos* Pierce, 1909a; *Sceliphronecthrus* Pierce, 1909b; *Macroxenos* Schultze, 1925.

Male. Radius of the hind wing with the detached apical portion distinct and originating posterior to the main vein; otherwise similar to *Xenos.* Metathoracic scutellum strongly narrowed anteriorly and with its anterior edges usually convergent but sometimes almost parallel. Metathoracic postlumbium not strongly spindle-shaped but frequently somewhat constricted at the middle. Ædeagus extremely variable according to species and apparently without generic significance.

Female. Cephalothorax darker on the anterior one-half than on the posterior one-half. Abdomen with three genital tubes entering the brood canal, as contrasted with four in *Xenos.*

First Stage Larva. Each eye composed of five ocelli, three dorsal, one lateral, and one ventral. Hind femur with one apical bristle, hind tibia with one outer bristle and three inner bristles, hind tarsus with a small subterminal pulvillus giving it a forked appearance in profile. Abdomen with six rows of stout bristles on sternites two to seven. Sternite nine bearing a pair of short stout tubercles furnished with long apical bristles and very short subapical ones. Tenth abdominal segment with a pair of latero-dorsal spines which are approximately half as long as the terminal stylets.

STYLOPIZED HYMENOPTERA FROM NORTH CAROLINA

It is interesting to note that only very rarely has the State of North Carolina been included as a locality in lists of

Hymenoptera parasitized by Strepsiptera. The only previous record with which the author is familiar was made by George Salt, 1927, who recorded a parasitized specimen of *Chlorion pennsylvanicum* (Linn.) from Southern Pines.

Additional records are now available thru the efforts of Mr. C. S. Brimley of the North Carolina Department of Agriculture who has sent the author a number of stylopized specimens and furnished additional records by letter.

Whenever possible the identity of the parasite has been determined and included in the following list. The portion of each reference before the colon refers in every case to the host and that after the colon to the parasite.

Sphecidae

Chlorion (*Ammobia*) *flavitarsus* (Fernald). Swannanoa, Sept. 3, 1924, one specimen, T. B. Mitchell coll.: mature male, *Pseudoxenos*[1] sp. near *smithii* (Von Heyden).

Chlorion (*Ammobia*) *habenum* (Say). Raleigh, Aug. 24, 1921, two specimens, C. S. Brimley coll.: male puparium and female, *Pseudoxenos* sp. near *smithii* (Von Heyden).

Chlorion (*Ammobia*) *ichneumoneum* (Linn.). Raleigh, June 16, 1933, three specimens, D. L. Wray coll.: male puparium, exuvia, and two females, *Pseudoxenos smithii* (Von Heyden).

Chlorion (*Ammobia*) *pennsylvanicum* (Linn.). Raleigh, Sept. 2, 1927, two specimens; Aug. 6, 1924, one specimen; Aug. 6, 1904, one specimen; C. S. Brimley coll.: male puparium, exuvia, and three females, *Pseudoxenos* sp. near *smithii* (Von Heyden).

Sphex aureonotatus (Cam.) (det. by H. T. Fernald). Raleigh, mid June, 1914, one specimen, C. L. Metcalf coll. Raleigh, mid July (no year), three specimens; Sept. 8, 1921, one specimen; Sept. 9, 1904, one specimen; Sept. 13, 1921, one specimen; C. S. Brimley coll. Raleigh, mid Sept., 1921, T. B. Mitchell coll. Willard,

---

[1] Refer to *Homilops* Pierce and *Ophthalmochlus* Pierce in the synopsis of this paper.

July 15, 1925, one specimen, C. S. Brimley coll. Charlotte, July 6, 1921, one specimen, T. B. Mitchell coll. Elizabeth City, early Aug., 1919, one specimen, F. Sherman coll.: two mature males, two male puparia, two exuviae, and thirteen females, *Pseudoxenos* sp.[1]

Sphex urnarius (Dahlb.) (det. by H. T. Fernald). Raleigh, June 30, 1921, one specimen; Sept. 13, 1921, one specimen; early Nov. (no year), one specimen; C. S. Brimley coll. Southern Pines, June 11, 1911, A. H. Manee coll.: four exuviae and three females, *Pseudoxenos* sp. (apparently the same species as that on *S. aureonotatus*).

Vespidæ

Ancistrocerus fulvipes (Sauss.). Raleigh, Aug. 13, 1925, one specimen, C. S. Brimley coll.: female, *Pseudoxenos* sp.

Odynerus pedestris Sauss. Raleigh, mid April, 1921, one specimen, C. S. Brimley coll.: male puparium and female, *Pseudoxenos* sp. (probably *pedestridis* Pierce).

Zethus spinipes Say var. *variegatus* Sauss. Beaufort, Aug. 11, 1902, one specimen, F. Sherman coll.: female, probably *Pseudoxenos* sp.

Polistes canadensis (Linn.) var *annularis* (Linn.) Biltmore, July 29, 1933, one specimen, D. L. Wray coll.: female, *Xenos pallidus* Brues.

Polistes fuscatus (Fabr.) var. *pallipes* (Lepel). Raleigh, Apr. 10, 1905, one specimen, G. M. Bentley coll.; mid Oct., 1917, one specimen, J. E. Eckert coll. Currituck, June 5, 1935, one specimen, D. L. Wray coll. Fayetteville, June 25, 1933, one specimen, D. L. Wray coll. Elizabeth City, mid Aug., 1919, one specimen, F. Sherman coll.: one mature male, three male puparia, exuviae, four females, *Xenos peckii* Kirby.

Polistes fuscatus (Fabr.) var *variatus* (Cresson). Raleigh, June 7, 1933, one specimen, D. L. Wray coll. Asheville, Sept. 6, 1932, one specimen, D. L. Wray coll.: eight male puparia and one female, *Xenos peckii* Kirby.

---

[1] Refer to *Eupathocera* Pierce in the synopsis of this paper.

Andrenidæ

Andrena sp. Raleigh, Mar. 24, 1925, one specimen on willow, T. B. Mitchell coll.: female, *Stylops* sp.

Halictidæ

Halictus (*Chloralictus*) sp. Late May, 1921, one specimen on *Penstemon,* T. B. Mitchell coll.: female *Halictoxenos crawfordi* Pierce.

Halictus (*Chloralictus*) *sparsus* Robt. Bryson City, no date: *Halictoxenos sparsi* Pierce. (Host and parasite determined by J. C. Crawford).

Halictus (*Chloralictus*) *versatus* Robt. Bryson City, July 8, 1923: *Halictoxenos versati* Pierce. (Host and parasite determined by J. C. Crawford).

Halictus (*Chloralictus*) *zephyrus* Smith. Bryson City, Aug. 23, 1923: *Halictoxenos zephyri* Pierce. (Host and parasite determined by J. C. Crawford).

Panurgidæ

Panurginus sp. Bryson City, no date: *Crawfordia* sp. (Recorded by J. C. Crawford).

The last four references above were taken from correspondence with Mr. C. S. Brimley.

With records from Bryson City, Biltmore, Asheville, and Swannanoa in the west; Charlotte, Southern Pines, Fayetteville, and Raleigh in the central portion; and Beaufort, Elizabeth City, and Currituck in the east; Strepsiptera are now well represented in records from North Carolina.

REFERENCES

Esaki, T. 1932. Strepsiptera, in Iconographia Insectorum Japanicorum. Nippon Konchu Zukan, Hokuryukan, Tokyo.

Monod, T. 1925. Sur un Pseudoxenos parasite d'Odynerus crenatus Lepeletier. Bull. Soc. Zool. Paris, vol. 50, pp. 230-244, 3 figs.

Ogloblin, A. A. 1924. New and little known Strepsiptera from Poland. Polskie Pismo Entomologiczne, vol. 3, pp. 113-122, illus.

Pierce, W. D. 1908. A preliminary review of the classification of the order Strepsiptera. Proc. Ent. Soc. Wash., vol. 9, pp. 75-85.

———— 1909. A monographic revision of the twisted winged insects comprising the order Strepsiptera Kirby. Bull. U. S. Nat. Mus., No. 66, pp. 1-232, 15 Pls.

———— 1911. Notes on insects of the order Strepsiptera with descriptions of new species. Proc. U. S. Nat. Mus., vol. 40, pp. 487-511.

———— 1918. The comparative morphology of the order Strepsiptera together with records and descriptions of insects. Proc. U. S. Nat. Mus., vol. 54, pp. 391-501, 15 Pls.

Salt, G. 1927. Notes on the Strepsiptera and their hymenopterous hosts. Psyche, vol. 34, pp. 182-192.

Saunders, S. S. 1872. Stylopidarum, ordinem Strepsipterorum Kirbii constituentium, mihi tamen potius Coleopterorum familiae, Rhipiphoridis Meloidisque propinquae, monographia. Trans. Ent. Soc. Lond. Part I, (April) pp. 1-48, 1 Pl.

Schultze, W. 1925. Macroxenos pierci, a new genus and species of wasp parasites from the Philipine Islands. Phil. Jour. Sci., vol. 27, pp. 238, illus.

BIOLOGY OF THE TACHINID *WINTHEMIA DATANÆ* TNS.

By Frank L. Marsh

Union College, Lincoln, Nebraska

In a recent study of the parasites of Cecropia in the Chicago area based on the examination of over three thousand Cecropian cocoons collected in that region[1] some interesting facts were discovered in the life-history of the tachina fly *Winthemia datanae* Tns. For the identification of this insect the writer is indebted to Mr. J. M. Aldrich of the U. S. National Museum. In this instance every case of tachinid parasitization appeared to be the work of this single species. Over the entire area at least three percent of the mature Cecropian larvæ were destroyed by this insect.

Emergence, Breeding Habits, and Oviposition

During a normal season the first adults emerge the second week in July. This appearance happens to be well timed because at that juncture the earliest of the Cecropian larvae have molted the last time before spinning their cocoons. When considered over the whole area the parasitization is rather light but it is the habit of this tachinid to work in limited spots probably including a half dozen trees. In these sporadic areas the infestation is heavy often amounting to the total destruction of the host larvae. Where taller trees were infested by Cecropia six times as many of its cocoons were parasitized by this tachinid when spun below the fifteen-foot level as when spun above that level.

Copulation and egg-laying occur rather intermittently. The males rest on the leaves of the infected trees, at times engaging the females during temporary cessation of their egg-laying activities. During oviposition the female hovers over the back of the larva, clinging to its tubercles while the eggs are securely attached by their adhesive coating to the skin of the host along the dorsal line. The largest number observed on one larva was 76 while the average was 21. In every case observed larvæ in the earlier stages were passed by, eggs being placed only on those which had molted the last time before spinning. Because of this adaptive behavior the eggs are not shed with the larval skin at molting time. The host larvæ give little heed to the egg-laying, only temporarily stopping their feeding. Oviposition occured more commonly in the latter part of the afternoon on the shaded side of trees and bushes.

---

[1] Marsh, F. L. 1934. "A Regional Study of *Samia cecropia* and Nine Associated Parasites and Hyperparasites." An unpublished Master's Thesis in the Northwestern University Library, Evanston, Illinois.

Egg and Larva

The eggs are white and measure about 0.8 mm. x 0.3 mm. In about thirty-six hours the endophagous larva gnaws an opening near one end on the adhering side of the egg and tunnels down directly into the cœlomic fluid of its host. Bacterial action causes a blackening of the area of the cuticle where the tunneling occurs and a characteristic dried patch appears around the egg shells in a few hours.

The larvae develop rapidly but due to the eggs having been laid on mature larvæ the host almost invariably completes at least the outer shell of its cocoon before being killed. Such cocoons are usually white in color. If few tachinid larvæ are present the cocoon may be fully completed before the host larva is killed. In every case observed the infected larva always died although it may have been parasitized by but a single tachinid larva. In instances of heavy infestation death of the host occurs in three or four days after the parasites emerge from the eggs.

The dead host turns brown in color and usually presents a distended appearance. Oxygen seems very essential to adult tachinid larvæ, evidenced by an opening which is invariably made in the skin of the host, usually on the ventral surface. This same hole is later used as an exit from the tough, dried skin of the host. The larvæ mature in from six to eight days and may crawl out immediately or may rest for a time in the dried host skin. If a cocoon containing adult maggots is agitated even slightly the parasites appear much disturbed and usually crawl out immediately.

Once outside the dead host's skin, the larva finds itself still a prisoner in the Cecropian cocoon. It never punctures this cocoon and not uncommonly dies from dehydration before it can escape. The only way out is through the valve of the cocoon. The larva has no fear of dropping and its tough skin insulates it effectively from the shock of landing. In an experiment a handful of these larvae were tossed from a third-story window to cement below. Though bounding several feet with the force of the impact still they began to wriggle away immediately and in each case pupated later, apparently uninjured by the experience.

Upon reaching the ground the maggot at once begins to push into the soil. The depth to which it penetrates depends on how far it must go to find reasonably damp soil, usually from three to eight inches. At the proper depth the soil is pushed out till a cell is formed in which the larva will either pupate after a few days and emerge as an adult in about a week or the larva will hibernate through the winter and pupate the following July. In the region studied the second brood of this tachinid in a summer was the exception rather than the rule. Proper moisture appears to be very necessary for the survival of the larva or puparium. For that reason puparia formed in the host cocoon where the larvæ have failed to escape must immediately develop into adults or perish. If adults chanced to emerge in such situations, they could not escape from the host cocoon. In this study the only successful individuals were those which pupated in the ground.

Three reasons why *W. datanae* is not a more effective parasite of Cecropia in the Chicago area are its habit of ovipositing only on mature larvae, the failure of many of the maggots to escape from the host cocoon, and the great sensitiveness to dehydration on the part of both hibernating larvæ and the puparia.

NOTES ON THE COURTSHIP AND MATING OF THE FLY, *PTECTICUS TRIVITTATUS* SAY[1]

By Phil Rau

Kirkwood, Missouri

During several summers before these notes were made in 1930 and also several summers afterwards, large numbers of these attractive greenish-colored flies were seen hovering in courtship dances above garbage heaps on the rear of a lot. They were first observed on the 20th day of May of that year and they continued their activities over this restricted area until the middle of July; to be exact, they appeared in much reduced numbers on July 19th and had completely disappeared by July 25th. There are probably two generations a year, for they again appeared on August 22nd and were seen thereafter until September 11th.

They spend much of their time flying slowly and noiselessly over this "island" of color and odor commencing sometimes as early as 5:30 in the morning when only a few may be seen; they increase in numbers with the passing of the hours and the rising of the temperature. They dance almost incessantly throughout the long day, and even into the dusk may the motion of their frail forms be seen. To say that they dance incessantly is not wholly true for individuals often leave the throng to rest on a tin-can or bottle or cantaloupe skin. The temperature readings when these dances occur varies from 65 to 75 degrees F.; one can, however, hardly refer to the phenomenon as a "sun dance" because the flies are equally active in sunshine or shade, as well as in shadowy stretches splashed with spots of sunlight. Both males and females are present in the dance, and the sexes are about equal.

It is, indeed, a pretty sight to see a flock of these flies moving in a horizontal plane in more-or-less irregular circles and in figure eights just an inch or two above the mass of multi-colored refuse. As one singles out certain individuals, however, one soon realizes that frequently they describe circles within still larger circles. Each fly circles about horizontally in an area of ten or twelve inches with occasional breaks by an insect into another's circle; all this gives the assemblage a placid and slow-moving appearance. Often a fly will leave the dance to rest on a tin-can or on a glass bottle, many of which stud the heap. Sometimes one will go in pursuit of another and quarreling occurs. When the quarrel culminates mating usually takes place. Mating is consummated while they are on the wing but the pair soon settle down amid the garbage to rest, remaining in copulo for 10 or 15 minutes. So intent are they in this affair that the object upon which they repose may be carried for a long distance without arousing them.

---

[1] Specimens were kindly identified by Mr. C. T. Greens of U. S. Dept. of Agriculture.

When one examines a mated pair closely one finds that the larger insect, the female, is invariably on top of the smaller one, the male. Both heads are close together and during the process the female caresses the face and eyes of the male with her front legs. This behavior is very much like that of a fond mother petting her child. It is quite evident that the male enjoys this procedure, for he responds by licking her leg with his proboscis. Often his mouth parts will actually reach out to meet her leg, but sometimes he holds them alert in attentive readiness. One pair behaved this way for 15 minutes while I held the bottle upon which they rested in my hand.

The flies, singly or *in copula,* never rest on the moist portions of the garbage but always upon some hard dry object in the mass. Sometimes they rest on the grass-stems near their stamping grounds. They have never been seen to feed on garbage and I have never seen them lay eggs there, although I have watched carefully to detect both activities. However, oviposition must occur on objects nearby and also very soon after mating, for on one occasion when a mated pair separated in my hand, the female deposited about a hundred eggs in less than ten minutes.

PSYCHE

INDEX TO VOL. XLIV, 1937

INDEX TO AUTHORS

Beilmann, A. P. Social Behavior in Homoptera. 58.

Bohart, R. M. Synonymy of the Genus Pseudoxenos Saunders (Strepsiptera, Xenidæ) and Records of Stylopized Hymenoptera from North Carolina. 132.

Brues, C. T. Prof. Wm. M. Wheeler, With a List of His Published Writings. 61.

Copeland, M. & S. Crowell. Observations and Experiments on the Case-building Instinct of Two Species of Trichoptera. 125.

Creighton, Wm. S. Notes on the Habits of Strumigenys. 97.

Darlington, P. J., Jr. A New Paussid Beetle from Central America. 56.

Darlington, P. J., Jr. West Indian Carabidæ IV: Three New Colpodes. 122.

Dethier, V. G. Cannibalism Among Lepidopterous Larvæ. 110.

Dow, R. The Scientific Work of Albert Pitts Morse. 1.

Hull, F. M. New Species of Exotic Syrphid Flies. 12.

Hull, F. M. A Megamorphic and Two Curious Mimetic Flies. 116.

Marsh, F. L. Biology of the Tachinid *Winthemia datanæ* Tns. 138.

Obituary—Wm. M. Wheeler. 60.

Rau, P. Notes on the Courtship and Mating of the Fly, *Ptecticus trivittatus* Say. 141.

Thery, A. New Buprestid Beetles Collected in the Solomon Islands and Fiji Islands by Dr. W. M. Mann, with Descriptions of Some Other New Indo-Malayan Species. 33.

INDEX TO SUBJECTS

All new genera, new species and new names are printed in SMALL CAPITAL LETTERS.

Agrilus fidjiensis, 51
AGRILUS LEVUENSIS, 50
AGRILUS MANNIANUS, 48

Biology of *Winthemia datanae* Tns., 138
Book Review, 59
Buprestid Beetles from Solomon and Fiji Islands, 33

Cannibalism Among Lepidopterous Larvæ, 110
Case-building Instinct of Two Species of Trichoptera, 125
CERIOMICRODON, 25
CERIOMICRODON PETIOLATUS, 25
CHYSIDIMYIA, 116
CHYSIDIMYIA CHRYSIDIMIMA, 117
COLPODES BROMELIARUM, 122
COLPODES ROYSI, 124
COLPODES SELLENSIS, 122
Courtship and Mating of *Ptecticus trivittatus*, 141

DICEROPYGUS BREVICOLLIS, 42
DICEROPYGUS STEVENSI, 40
DICEROPYGUS VARIEGATUS, 44

EUMERUS OBTUSICEPS, 16

HAPLOTRINCHUS MANNI, 37
HOMOPTERUS HONDURENSIS, 56
Hymenoptera from North Carolina, 132
HYPSELOSYRPHUS, 21
HYPSELOSYRPHUS TRIGONUS, 21

Index to Vol. 44, 145

Korinchia simulans, 16

LATHYROPHTHALMUS VITRESCENS, 15
Lepidopterous Larvæ, 110

Megamorphic and Mimetic Flies, 116
Melobasis albertisi, 40
MEROMACRUS MELMOTH, 12
MICRODON ARGENTINÆ, 18
MICRODON DIGITATOR, 19
MICRODON INVESTIGATOR, 20
Morse, Albert Pitts, Scientific Works, 1

NOSOTRINCHUS SOLOMONENSIS, 38

Obituary—W. M. Wheeler, 60
OLIGERIOPS, 26
OLIGORHINA, 30
OLIGORHINA AENEA, 31

PAPILIOMYIA, 27
PAPILIOMYIA SEPULCHRASILVA, 28
PARACUPTA EVANSI, 33
PARACUPTA MANNI, 35
Paracupta meyeri, 33
PARAMICRODON DELICATULUS, 24
PARAMICRODON NOVUS, 22
Paussid Beetle from Central America, 56
PIPUNCULOSYRPHUS, 29
PIPUNCULOSYRPHUS GLOBICEPS, 30
PSEUDOMICRODON, 24
Pseudoxenos, 133
Ptecticus trivittatus, 141

SAMBUS DARLINGTONI, 46
SAMBUS MANNI, 45
Social Behavior in Homoptera, 58
STENOMICRODON, 26
STENOMICRODON PURPUREUS, 26
Strumigenys, Habits, 97
Stylopized Hymenoptera, 132
SYRPHIPOGON, 120
SYRPHIPOGON FUCATISSIMUS, 120
SYRPHUS CINEREOMACULATUS, 28

TITYUSIA, 118
TITYUSIA REGULUS, 119
TRACHYS DARLINGTONI, 52

VELOCIMYIA, 13
VELOCIMYIA VELOX, 14

West Indian Carabidæ, 122
William Morton Wheeler, with complete List of his published Writings, 61
Winthemia datanae, 138

PIN-LABELS IN MULTIPLES OF 1000, ALIKE

One Dollar Per Thousand

Smallest Type. Pure White Ledger Paper. Not over 4 Lines nor 30 Characters (13 to a line) Additional Characters, 3 cents each, in total and per line, per 1000. Trimmed so one cut makes a label.

C. V. BLACKBURN, 7 Emerson St., STONEHAM 80, MASS.

CAMBRIDGE ENTOMOLOGICAL CLUB

A regular meeting of the Club is held on the second Tuesday of each month (July, August and September excepted) at 7.45 p.m. in Room B-455, Biological Laboratories of Harvard University, Divinity Ave., Cambridge. Entomologists visiting Boston are cordially invited to attend.

WARD'S ENTOMOLOGICAL SERVICES

Entomological Supplies and Equipment

Carefully designed by professional entomologists. Material of high quality at low prices. **Send for Supply Catalog No. 348.**

Insect Preparations

Life Histories, Type Collections, Collections of Economic Insects and Biological Insect Collections. All specimens are accurately determined.

Insects for the Pest Collection

We have in stock over three hundred species of North American Insect Pests. **Send for Price List No. 349.**

Ward's Entomological Bulletin

A monthly publication sent free to all entomologists requesting it.

Information for the Beginner

Send for "**Directions for Collecting and Preserving Insects**" by Dr. A. B. Klots. A mine of useful information. Price 15 cents.

WARD'S NATURAL SCIENCE ESTABLISHMENT, Inc.
P. O. Box 24, Beechwood Station
Rochester, N. Y., U. S. A.
The Frank A. Ward Foundation of Natural Science of the University of Rochester

BACK VOLUMES OF PSYCHE

The Cambridge Entomological Club is able to offer for sale the following volumes of Psyche. Those not mentioned are entirely out of print.

Volumes 2, 3, 4, 5, 6, 7, 8, 9, 10; each covering a period of three years, $5.00 each.

Volumes 12, 14, 17, each covering a single year, $1.00 each.

Volumes 18, 19, 20, 21, 22, 23, 24, 25, 26, each covering a single year, $1.50 each.

Volumes 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, each covering a single year, $2.00.

Orders for 2 or more volumes subject to a discount of 10%.

Orders for 10 or more volumes subject to a discount of 20%.

A set of all the volumes available (40 in all) will be sold for $79.00.

All orders should be addressed to

F. M. CARPENTER, Associate Editor of Psyche,
Biological Laboratories,
Harvard University,
Cambridge, Mass.